Site: Apples	**Overall Confidence Rating: High**

Background: A total of 641,000 acres are planted in apples in the United states. Organophosphate pesticides (OP) represent 68% of all pesticide usage on this crop with an average of 2.82 applications per year. Analysis of OP usage was conducted for the following five major apple regions: New England (CT, MA, ME, RI, NH, NJ, NY, VT) , North Central (MI and OH), Appalachian-Southern (DE, GA, MD, NC, PA, SC, TN, VA, WV), Western (AZ and CA), and Pacific North. (OR and WA). Insecticide use patterns and key pests vary both between and within regions. In the absence of effective controls, key pests can destroy 50-90% of the crop. Due to low damage threshold levels in apples, biological control is limited to indirect pests (non-fruit feeding) with little contribution against direct pests.

Organophosphate	% Treated		# Applications		Rate (lb AI/A)		PHI (days)	
Pesticides	Max[23]	Avg[23]	Max[21]	Avg[2-11]	Max[21]	Avg[2-11]	Min[21]	Avg
azinphos-methyl	64.7	61.4	4	2.1	3.1	0.8	7	
chlorpyrifos	53	44	NS	1.6	4	1.4	30	
diazinon	6	3	NS	1.6	5	1.2	21	
dimethoate	14.9	7.4	NS	1.3	2.0	0.8	28	
malathion	15	10	NS	1.1	2.3	0.8	21	
methyl parathion	25	18	NS	1.0	2	2.0	21	
phosmet	34	22	NS	2.9	4	1.1	7	

Confidence Rating: H= high confidence = data from several confirming sources; confirmed by personal experience
M = medium confidence = data from only a few sources; may be some conflicting or unconfirmed info.
L = low confidence = data from only one unconfirmed source

Organophosphate Target Pests for Apple in New England Region (Primary pests controlled by the OP's)[6, 9, 17, 18]	
Major	Bug (Tarnished Plant), Aphids (Rosy Apple, Apple, and Spirea), Apple Maggot, Plum Curculio
Moderate	Leafroller (Obliquebanded and Redbanded))
Minor	Fruitworm (Green and Sparganothis), Sawfly (European Apple), Leafhopper (White Apple and Potato), Scale (San Jose), Mite (European Red), Leafminer (Spotted Tentiform)

Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor =<5% of all OP usage on pest

Organophosphate Target Pests for Apple in North Central Region (Primary pests controlled by the OP's)[7, 10, 16]	
Major	Codling Moth, Apple Maggot
Moderate	Aphid (Green Apple and Rosy Apple), Fruitworm (Green), Leafroller (Fruit Tree, Red Banded, Oblique Banded, and Variegated), Scale (San Jose), Plum Curculio,
Minor	Mites (European Red, Rust, and Two Spotted Spider), Fruit/Bud Moth (Oriental Fruit, Tufted Apple Bud, and Eye-Spotted Bud), Leafminer (), Bug (Tarnished Plant and Stink), Leafhopper (White Apple and Potato), Borer (Dogwood)

Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor =<5% of all OP usage on pest

Organophosphate Target Pests for Apple in Appalachian-Southern Region (Primary pests controlled by the OP's)[3, 4 ,14, 15]	
Major	Aphid (Rosy Apple, Apple, Spirea and Apple Grain), Codling Moth
Moderate	Leafroller (Red Banded and Oblique Banded), Scale (San Jose), Mites (European Red, Twospotted Spider, and Apple Rust), Bug (Tarnished Plant and Mullein Plant), Leafhopper (White Apple, Rose, and Potato)
Minor	Fruit/Bud Moth (Tufted Apple Bud and Oriental Fruit), Leafminer (Spotted Tentiform), Plum Curculio, Apple Maggot, Fruitworm (Green)

Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor =<5% of all OP usage on pest

Organophosphate Target Pests for Apple in Western Region (Primary pests controlled by the OP's)[8, 19, 20]	
Major	Aphid (Rosy Apple, Green Apple, and Green Peach), Codling Moth
Moderate	Scale (San Jose, Italian Pear, and Grape Mealybug)
Minor	Mites (European Red, Apple Rust, Pacific Spider, and McDaniel Spider), Borer (Pacific Flatheaded)

Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor =<5% of all OP usage on pest

Organophosphate Target Pests for Apple in Pacific North Region (Primary pests controlled by the OP's)[2, 11, 12, 13]	
Major	Leafrollers (Pandemis, Oblique Banded, Fruittree, and European), Codling Moth
Moderate	Scale (San Jose and Oystershell), Fruitworm (Green, Speckled Green, and Pyamidal), Apple Maggot, Aphid (Green Apple, Rosy Apple, and Apple Grain), Mites (European Red, Apple Rust, Twospotted Spider, and McDaniel Spider)
Minor	

Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor =<5% of all OP usage on pest

Sources:

1. Proprietary EPA market share information.
2. U.S. Apple QUA+ - Washington. 1997.
3. U.S. Apple QUA+ - Virginia, West Virginia. 1997.
4. U.S. Apple QUA+ - Georgia, North Carolina, South Carolina and Tennessee. 1997.
5. U.S. Apple QUA+ - Pennsylvania. 1997.
6. U.S. Apple QUA+ - New England. 1997.
7. U.S. Apple QUA+ - Michigan. 1997.
8. U.S. Apple QUA+ - California. 1997.
9. QUA+ - New England Fruit Consultants.
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11. QUA+ - Northwest Horticultural Council. 1997.
12. Orchard Pest Management; A Resource Book for the Pacific Northwest.1993. Good Fruit Grower, Yakima, WA.
13. Pacific Northwest 1998 Insect Control Handbook. 1998. Oregon State University.
14. 1997 Spray Bulletin for Commercial Tree Fruit Growers. Virginia, West Virginia and Maryland Cooperative Extension.
15. Pennsylvania Tree Fruit Production Guide. 1996-1997. College of Agricultural Science, Penn State University.
16. 1997 Fruit Spraying Calendar for Commercial Fruit Growers. 1997. Bulletin E-154. Michigan State University Extension.
17. Pest Management Recommendations for Commercial Tree Fruit Production. 1997. Cornell University.
18. 1996-1997 New England Apple Pest Management Guide. Cooperative Extension (Universities. of Connecticut, New Hampshire, Maine, Rhode Island, Massachusetts and Vermont)
19. Apple Pest Management Guidelines. 1996. UCPMG Publication 12. IPM Education and Publications, Univ.- CA, Davis.
20. Integrated Pest Management for Apples and Pears. 1991. Publication 3340. University of California.
21. Label Use Information System (LUIS) Version 5.0, EPA.
22. The All-Crop, Quick Reference Insect Control Guide (1997), Meister Publishing Company
23. EPA Crop Profile QUA.

Date: 01/28/99

Site: Apple
Region: Appalachian-Southern

Pest[2-4, 7]	Organophosphate[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Class	Alt. Pesticide List[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Constraints of Alternatives[2, 7]
Timing: Pre-Bloom								
Aphid (Rosy Apple, Apple, Spirea, and Apple Grain) (Major)	azinphos-methyl	●	Lo	C	carbaryl	●	Lo	**Pyrethroid** and **Carbamate** use in late prebloom can create mite problems due to its high toxicity to predators. Use could require mite control with potential to develop resistant populations. Also may contribute to increased scale and wooly apple aphid problems. **Endosulfan** is more expensive. Efficacy of alternatives varies by species
	chlorpyrifos	● - ☺	Med	C	methomyl	● - ❍	Lo	
	diazinon	● - ☺	Lo	C	oxamyl	● - ❍	Lo	
	dimethoate	❍	Med	P	esfenvalerate	● - ☺	High	
	malathion	●	Lo	P	permethrin	● - ☺	Lo	
	phosmet	●	Lo	CH	endosulfan	● - ☺	Lo	
				O	oil	● - ❍	Lo	
Mites (European Red, Twospotted Spider, and Apple Rust) (Moderate)	chlorpyrifos	●	Med	C	oxamyl	❍	Med	**Oil** only effective against European red mite Efficacy of alternatives varies according to targeted pest species and area.
	diazinon	●	Lo	P	permethrin	●	Lo	
				P	pyrethrin	●	Lo	
				CH	dicofol	● - ☺	Lo	
				O	abamectin	☺	Lo	
				O	chinomethionate	● - ❍	Lo	
				O	clofentezine	☺	Lo	
				O	fenbutatin oxide	❍	Lo	
				O	formetantate hydrochloride	● - ❍	Med	
				O	hexythiazox	☺	High	
				O	petroleum oil	☺	High	
				O	soap	● - ❍	Lo	

Pest Importance: Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor = <5% of all OP usage on pest
Efficacy Rating: Excellent = ☺ Good = ❍ Fair = ● --- = Not rated for efficacy in state recs.
Market Share: High = 20+% OP usage on pest; Med = 5-20% of all usage on pest; Lo = <5% of all usage on pest; --- = not available for 1994-96.
Insecticides: C = Carbamates; P = Pyrethroids; CH = Chlorinated Hydrocarbons; IGR = Insect Growth Regulators; B = Biological; O = Other pesticide

Site: Apple
Region: Appalachian-Southern

Pest[2-4, 7]	Organophosphate[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Class	Alt. Pesticide List[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Constraints of Alternatives[2, 7]
Timing: Pre-Bloom								
Scale (San Jose) (Minor)	azinphos-methyl	●	Lo	C	carbaryl	●	Lo	**Pyrethroid** use in late prebloom period can create mite problems due to its high toxicity to predators. Use of pyrethroids during prebloom would necessitate mite control and could lead to development of resistant populations. Pyrethroids may also contribute to increased scale and wooly apple aphid problems. **Carbamtes** are more toxic to mite predators (see pyrethroid). **Oil** is incompatible with some fungicides. Total reliance on oil will probably not be sufficient.
	chlorpyrifos	● - ☺	High	C	methomyl	● - ❍	Lo	
	dimethoate	❍	Lo	P	esfenvalerate	●	Lo	
	diazinon	❍	Lo	P	permethrin	●	Lo	
	malathion	●	Lo	CH	endosulfan	●	Lo	
	methidathion	☺	High	O	abamectin	❍	Lo	
	methyl parathion	☺	Lo	O	insecticidal soap	---	---	
	phosmet	●	Lo	O	oil	☺	High	
Leafroller (Red banded and Oblique banded) (Minor)	azinphos-methyl	❍	High	C	carbaryl	●	Lo	**Esfenvalerate** use in late prebloom period can create mite problems due to its high toxicity to predators. Use of esfenvalerate would necessitate mite control and could lead to development of resistant populations. Pyrethroids may also contribute to increased scale and wooly apple aphid problems. **Carbamates** are more toxic to predators of mites and have very short residual. **Mating disruption** is not as effective and more expensive.
	chlorpyrifos	● - ☺	Med	C	methomyl	❍ - ☺	Med	
	diazinon	● - ❍	Lo	P	esfenvalerate	☺	Lo	
	methyl parathion	❍ - ☺	Med	P	permethrin	☺	Lo	
	phosmet	❍	Lo	B	Bacillus thuringiensis	❍ - ☺	Lo	

Pest Importance: Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor = <5% of all OP usage on pest
Efficacy Rating: Excellent = ☺ Good = ❍ Fair = ● --- = Not rated for efficacy in state recs.
Market Share: High = 20+% OP usage on pest; Med = 5-20% of all usage on pest; Lo = <5% of all usage on pest; --- = not available for 1994-96.
Insecticides: C = Carbamates; P = Pyrethroids; CH = Chlorinated Hydrocarbons; IGR = Insect Growth Regulators; B = Biological; O = Other pesticide

Site: Apple
Region: Appalachian-Southern

Pest[2-4, 7]	Organophosphate[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Class	Alt. Pesticide List[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Constraints of Alternatives[2, 7]
Timing: Pre-Bloom								
Leafminer (Spotted tentiform) (Minor)	azinphos-methyl	●	Lo	C	carbaryl	●	Lo	**Pyrethroids** and **Carbamates** are more toxic to predators and could disrupt mite IPM programs.
	diazinon	●	Lo	C	methomyl	☺	Lo	
	dimethoate	● - ❍	Lo	C	oxamyl	☺	Med	
	methyl parathion	●	Lo	P	esfenvalerate	☺	High	
	phosmet	●	Lo	P	permethrin	☺	Lo	
				P	pyrethin	❍	Lo	
				CH	endosulfan	❍	Lo	
				O	abamectin	☺	Lo	
				O	formetanate hydrochloride	❍	Lo	
Bug (Tarnished Plant and Mullein Plant) (Minor)	azinphos-methyl	●	Lo	C	methomyl	❍	Lo	**Pyrethroids**, though more efficacious against plant bugs than OP's, are disruptive to IPM and prone to resistance development. Use of pyrethroids could lead to explosion of mite, scale and wooly aphid populations. **Endosulfan** is more toxic to mite predators and is more expensive.
	chlorpyrifos	❍	Lo	C	oxamyl	❍	Lo	
	diazinon	❍	Lo	p	esfenvalerate	☺	High	
	dimethoate	❍	Med	p	permethrin	☺	Lo	
	methyl parathion	❍	Lo	CH	endosulfan	☺	Med	
	phosmet	●	Lo	O	formetanate hydrochloride.	❍	Lo	

ADDITIONAL INFORMATION:

Apple farming in the Appalachian-Southern Region (Delaware, Georgia, Maryland, North Carolina, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia) accounts for 14.1% of national apple acreage and 10.2% of total production[8]. OP's represent 35.2% of all pesticide usage in apple production during the Pre-Bloom period in the Appalachian-Southern region[1].

Pest Importance: Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor = <5% of all OP usage on pest
Efficacy Rating: Excellent = ☺ Good = ❍ Fair = ● --- = Not rated for efficacy in state recs.
Market Share: High = 20+% OP usage on pest; Med = 5-20% of all usage on pest; Lo = <5% of all usage on pest; --- = not available for 1994-96.
Insecticides: C = Carbamates; P = Pyrethroids; CH = Chlorinated Hydrocarbons; IGR = Insect Growth Regulators; B = Biological; O = Other pesticide

Site: Apple
Region: Appalachian-Southern

Usage level of OP's reflect the unavailability of effective alternative control measures (chemical, cultural, biological, etc.) Usage of OP's are largely driven by their lower disruption of other IPM programs (ie. biological control of mites) and cost.

SOURCES:

1. Proprietary EPA market share information.
2. U.S. Apple QUA+ - Georgia, Maryland, North Carolina, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia. 1997.
3. 1997 Spray Bulletin for Commercial Tree Fruit Growers. Virginia, West Virginia and Maryland Cooperative Extension.
4. Pennsylvania Tree Fruit Production Guide. 1996-1997. College of Agricultural Science, Penn State University.
5. The All-Crop, Quick Reference Insect Control Guide (1997), Meister Publishing Company.
6. Label Use Information System (LUIS) Version 5.0, EPA.
7. Consultation with Appalachian-Southern Extension and Research personnel and Apple producers.
8. Noncitrus Fruits and Nuts 1996 Summary. 1997. Agricultural Statistics Board, NASS, USDA.

Date: 01/28/99

Site: Apples
Region: Appalachian-Southern

Pest[2-4, 7]	Organophosphate[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Class	Alt. Pesticide List[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Constraints of Alternatives[2, 7]
Timing: Post-Bloom								
Codling Moth (Major)	azinphos-methyl	☺	High	C	carbaryl	❍	Lo	**Carbamates** generally have a shorter period of residual activity than OP's. **Pyrethroids** are not recommended post-bloom to avoid disrupting the biological control of Mites. **Pyrethroids** and **carbamates** would be more toxic to mite predators. Use of these products would necessitate mite control with increased miticide use and resistance development. Mating disuruption with **pheromone** is not cost effective given the pest complex and only works for low to moderate population densities.
	chlorpyrifos	❍ - ☺	Mod	C	methomyl	❍	Lo	
	diazinon	❍	Lo	P	esfenvalerate	☺	Lo	
	dimethoate	●	Lo	P	permethrin	☺	Lo	
	malathion	☺	Lo	CH	endosulfan	●	Lo	
	methyl parathion	☺	Mod	B	Bacillus thuringiensis	●	Lo	
	phosmet	☺	Mod	O	imidacloprid	---	---	
				O	pheromone	❍	Lo	
Leafroller (Red banded and Oblique banded) (Moderate)	azinphos-methyl	❍ - ☺	High	C	carbaryl	●	Lo	**Carbamates** and **pyrethroids**.have potential resistance problems and disrupt IPM.. Use would necessitate mite control with increased miticide use and mite resistance. **Methomyl** has very short residual.
	chlorpyrifos	● - ☺	Lo	C	methomyl	❍ - ☺	High	
	diazinon	● - ❍	Lo	P	esfenvalerate	☺	Lo	
	methyl parathion	❍ - ☺	High	P	permethrin	☺	Lo	
	phosmet	❍	Lo	B	Bacillus thuringiensis	❍ - ☺	Lo	
				O	phemone	● - ☺	---	

Pest Importance: Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor = <5% of all OP usage on pest
Efficacy Rating: Excellent = ☺ Good = ❍ Fair = ● --- = Not rated for efficacy in state recs.
Market Share: High = 20+% OP usage on pest; Med = 5-20% of all usage on pest; Lo = <5% of all usage on pest; --- = not available for 1994-96.
Insecticides: C = Carbamates; P = Pyrethroids; CH = Chlorinated Hydrocarbons; IGR = Insect Growth Regulators; B = Biological; O = Other pesticide

Pest[2-4, 7]	Organophosphate[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Class	Alt. Pesticide List[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Constraints of Alternatives[2, 7]
Timing: Post-Bloom								
Aphid (Rosy Apple, Apple, Spirea, and Apple Grain) (Moderate)	azinphos-methyl	●	Lo	C	carbaryl	●	Lo	**Pyrethroids** and **Carbamates** are more toxic to predators and could disrupt mite IPM programs. Aphid predators are inconsistent and especially so where carbamates and pyrethroids are used in cover sprays. With potential increased use of Pyrethroids, Wooly Apple Aphid control will become more important. **Endosulfan** is less efficacious, more expensive and more toxic to predatory mites. **Imidacloprid** is disruptive to mite IPM as a result of greater toxicity to predatory mites..
	chlorpyrifos	● - ☺	Lo	C	methomyl	● - ❍	Med	
	diazinon	● - ☺	Lo	C	oxamyl	● - ❍	Lo	
	dimethoate	❍	Med	P	esfenvalerate	❍ - ☺	Lo	
	malathion	●	Lo	P	permethrin	❍ - ☺	Lo	
	phosmet	●	Lo	CH	endosulfan	❍ - ☺	Lo	
				O	imidacloprid	☺	High	
				O	petroleum oil	● - ❍	Lo	
Bug (Tarnished Plant and Mullein Plant) (Moderate)	azinphos-methyl	❍	Med	C	methomyl	❍	Lo	**Pyrethroids**, though more efficacious against plant bugs than OP's, are disruptive to IPM and prone to resistance development. Use of pyrethroids could lead to explosion of mite, scale and wooly aphid populations. **Endosulfan** is more toxic to mite predators and is more expensive.
	chlorpyrifos	❍	Lo	C	oxamyl	❍	Lo	
	diazinon	❍	Lo	p	esfenvalerate	☺	Lo	
	dimethoate	❍	Med	p	permethrin	☺	Lo	
	methyl parathion	❍	Lo	CH	endosulfan	☺	Lo	
	phosmet	●	Med	O	formetanate hydrochloride	❍	Lo	

Pest Importance: Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor = <5% of all OP usage on pest
Efficacy Rating: Excellent = ☺ Good = ❍ Fair = ● --- = Not rated for efficacy in state recs.
Market Share: High = 20+% OP usage on pest; Med = 5-20% of all usage on pest; Lo = <5% of all usage on pest; --- = not available for 1994-96.
Insecticides: C = Carbamates; P = Pyrethroids; CH = Chlorinated Hydrocarbons; IGR = Insect Growth Regulators; B = Biological; O = Other pesticide

Site: Apples
Region: Appalachian-Southern

Pest[2-4, 7]	Organophosphate[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Class	Alt. Pesticide List[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Constraints of Alternatives[2, 7]
Timing: Post-Bloom								
Leafhopper (White Apple, Rose and Potato) (Moderate)	azinphos-methyl	●	Lo	C	carbaryl	❍ - ☺	Lo	**Pyrethroids**, **Carbamtes** and **Imidicloprid** are more toxice to predators of mites. Use of these pesticides would necessitate mite control with increased miticide use and mite resistance.
	diazinon	● - ❍	Lo	C	methomyl	❍ - ☺	High	
	dimethoate	❍ - ☺	High	C	oxamyl	● - ❍	Med	
				P	esfenvalerate	❍ - ☺	Lo	
				P	permethrin	❍ - ☺	Lo	
				CH	endosulfan	❍ - ☺	Lo	
				O	abamectin	● - ❍	Lo	
				O	formetanate hydrochloride	☺	Lo	
				O	imidacloprid	☺	Med	
				O	soap	❍	Lo	
Fruit/Bud Moth (Tufted apple and Oriental) (Minor)	azinphos-methyl	● - ❍	Med	C	carbaryl	● - ❍	Lo	**Carbamates** generally have shorter periods of residual efficacy than OP's. In addition, carbamates have potential resistance problems and disruption of IPM programs. **Pyrethroid** use during post-bloom is discouraged to avoid disrupting biological control of mites. **Phermone** disruption of mating is species specific and generally has low efficacy. Mating disruption is only effective where population densities are low to moderate.
	chlorpyrifos	❍ - ☺	Lo	C	methomyl	❍ - ☺	Med	
	diazinon	❍	Lo	C	oxamyl	●	Lo	
	dimethoate	●	Lo	P	esfenvalerate	☺	Lo	
	methyl partathion	❍ - ☺	High	P	permethrin	☺	Lo	
	phosmet	● - ❍	Med	CH	endosulfan	●	Lo	
				B	Bacillus thuringiensis	● - ☺	Lo	
				O	pheromones	---	--	

Pest Importance: Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor = <5% of all OP usage on pest
Efficacy Rating: Excellent = ☺ Good = ❍ Fair = ● --- = Not rated for efficacy in state recs.
Market Share: High = 20+% OP usage on pest; Med = 5-20% of all usage on pest; Lo = <5% of all usage on pest; --- = not available for 1994-96.
Insecticides: C = Carbamates; P = Pyrethroids; CH = Chlorinated Hydrocarbons; IGR = Insect Growth Regulators; B = Biological; O = Other pesticide

Pest[2-4, 7]	Organophosphate[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Class	Alt. Pesticide List[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Constraints of Alternatives[2, 7]
Timing: Post-Bloom								
Scale (San Jose) (Minor)	azinphos-methyl	●	Lo	C	carbaryl	●	Lo	**Imidacloprid**, **insecticidal soap** and **oil** are the only alternatives which can provide satisfactory control. Insecticidal soap should only be used on non-bearing trees. **Imidacloprid** and **insecticidal soap** cause mortality in predatory mites and may disrupt crop IPM. **Imidacloprid** is more expensive than current OP's. **Oil** is incompatible with some fungicides and is more phytotoxic under cold temperatures. Total reliance on oil will probably not be sufficient in the lon run with eventual increase in scales.
	chlorpyrifos	❍ - ☺	High	C	methomyl	● - ❍	Lo	
	dimethoate	❍	Lo	P	esfenvalerate	●	Lo	
	diazinon	❍	Lo	P	permethrin	●	Lo	
	malathion	●	Lo	CH	endosulfan	●	Lo	
	methyl parathion	❍ - ☺	High	O	abamectin	❍	Lo	
	phosmet	●	Lo	O	imidacloprid	---	---	
				O	insecticidal soap	---	---	
Plum Curculio (Minor)	azinphos-methyl	❍ - ☺	High	C	carbaryl	❍	Lo	Plum Curculio is very difficult to manage without OP's. Carbamates and Pyrethroids generally have lower efficacy against Plum Curculio and are more toxic to predators, necessitating mite control which could lead to resistance. .
	chlorpyrifos	❍	Lo	C	methomyl	● - ❍	Lo	
	dimethoate	●	Lo	P	esfenvalerate	❍ - ☺	Lo	
	diazinon	❍	Lo	P	permethrin	❍ - ☺	Lo	
	malathion	●	Lo	CH	endosulfan	●	Lo	
	methyl parathion	❍	High	O	imidacloprid		Lo	
	phosmet	❍ - ☺	High					

Pest Importance: Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor = <5% of all OP usage on pest
Efficacy Rating: Excellent = ☺ Good = ❍ Fair = ● --- = Not rated for efficacy in state recs.
Market Share: High = 20+% OP usage on pest; Med = 5-20% of all usage on pest; Lo = <5% of all usage on pest; --- = not available for 1994-96.
Insecticides: C = Carbamates; P = Pyrethroids; CH = Chlorinated Hydrocarbons; IGR = Insect Growth Regulators; B = Biological; O = Other pesticide

Pest[2-4, 7]	Organophosphate[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Class	Alt. Pesticide List[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Constraints of Alternatives[2, 7]
Timing: Post-Bloom								
Leafminer (Spotted tentiform) (Minor)	azinphos-methyl	●	Lo	C	carbaryl	●	Lo	**Pyrethroids** and **Carbamates** are more toxic to predators and could disrupt mite IPM programs.
	diazinon	●	Lo	C	methomyl	☺	High	
	dimethoate	● - ❍	Med	C	oxamyl	☺	Med	
	methyl parathion	●	Lo	P	esfenvalerate	☺	Lo	
	phosmet	●	Lo	P	permethrin	☺	Lo	
				P	pyrethrin	❍	Lo	
				CH	endosulfan	❍	Lo	
				O	abamectin	☺	Lo	
				O	formentate hydrochloride	❍	Lo	
				O	imidacloprid	☺	Med	
Fruitworm (Green) (Minor)	azinphos-methyl	● - ❍	High	C	carbaryl	●	Lo	**Pyrethroids** and **Carbamates** are more toxic to predators and could disrupt mite IPM programs.
	chlorpyrifos	❍	Med	C	methomyl	● - ❍	Lo	
	diazinon	❍	Lo	P	esfenvalerate	❍ - ☺	Lo	
	methyl parathion	● - ❍	Med	P	permethrin	❍ - ☺	Lo	
	phosmet	●	Med	CH	endosulfan	●	Lo	
				B	Bacillus thuringiensis	●	Lo	

Pest Importance: Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor = <5% of all OP usage on pest
Efficacy Rating: Excellent = ☺ Good = ❍ Fair = ● --- = Not rated for efficacy in state recs.
Market Share: High = 20+% OP usage on pest; Med = 5-20% of all usage on pest; Lo = <5% of all usage on pest; --- = not available for 1994-96.
Insecticides: C = Carbamates; P = Pyrethroids; CH = Chlorinated Hydrocarbons; IGR = Insect Growth Regulators; B = Biological; O = Other pesticide

Pest[2-4, 7]	Organophosphate[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Class	Alt. Pesticide List[1-5, 7]	Efficacy[2-4, 7]	Mkt[1]	Constraints of Alternatives[2, 7]
Timing: Post-Bloom								
Apple Maggot (Minor)	azinphos-methyl	☺	High	C	carbaryl	❍	Lo	Apple Maggot is a difficult pest to manage without OP's. **Pyrethroids** and **Carbamates** are generally less efficacious and more likely to disrupt biological control of mites which could lead to increased miticide usage and resistance. Border sprays with **Pyrethroids** or **Carbamates** may not provide complete control.
	chlorpyrifos	❍	Lo	C	methomyl	●	Lo	
	diazinon	❍	Lo	P	esfenvalerate	❍	Lo	
	dimethoate	● - ❍	Lo	CH	endosulfan	●	Lo	
	methyl parathion	❍	Lo	O	trapping	---	---	
	phosmet	☺	High					
Mite (European Red, Twospotted Spider, and Apple Rust) (Minor)	chlorpyrifos	●	Lo	C	oxamyl	❍	High	**Pyrethroids** and **Carbamates** are more toxic to predators and could disrupt mite IPM programs.
	diazinon	●	Lo	P	permethrin	●	Lo	
				P	pyrethrin	● - ❍	Lo	
				CH	dicofol	● - ☺	Med	
				O	abamectin	☺	Lo	
				O	chinomethionate	● - ❍	Lo	
				O	fenbutatin oxide	❍	Lo	
				O	formentate hydrochloride	● - ❍	Med	
				O	petroleum oil	☺	Med	
				O	soap	● - ❍	Lo	

Pest Importance: Major = 20+% of all OP usage on pest; Moderate = 5-20% of all OP usage on pest; Minor = <5% of all OP usage on pest
Efficacy Rating: Excellent = ☺ Good = ❍ Fair = ● --- = Not rated for efficacy in state recs.
Market Share: High = 20+% OP usage on pest; Med = 5-20% of all usage on pest; Lo = <5% of all usage on pest; --- = not available for 1994-96.
Insecticides: C = Carbamates; P = Pyrethroids; CH = Chlorinated Hydrocarbons; IGR = Insect Growth Regulators; B = Biological; O = Other pesticide

ADDITIONAL INFORMATION:

Apple farming in the Appalachian-Southern Region (Delaware, Georgia, Maryland, North Carolina, Pennsylvania, South Carolina, Tennessee, Virginia, and West Virginia) accounts for 14.1% of national apple acreage and 10.2% of total production[8]. OP's represent 63.8% of all pesticide usage in apple production during the Post-Bloom period in the Appalachian-Southern region[1].

Usage level of OP's reflect the unavailability of effective alternative control measures (chemical, cultural, biological, etc.) Usage of OP's are largely driven by their lower disruption of IPM programs (ie. biological control of mites) and cost.

Pyridaben may be an efficacious alternative to control mites but is not currently registered for use on apples.

SOURCES:

1. Proprietary EPA market share information.
2. U.S. Apple QUA+ - Georgia, Maryland, North Carolina, Pennsylvania, South Carolina, Tennessee, Virginia, West Virginia. 1997.
3. 1997 Spray Bulletin for Commercial Tree Fruit Growers. Virginia, West Virginia and Maryland Cooperative Extension.
4. Pennsylvania Tree Fruit Production Guide. 1996-1997. College of Agricultural Science, Penn State University.
5. The All-Crop, Quick Reference Insect Control Guide (1997), Meister Publishing Company.
6. Label Use Information System (LUIS) Version 5.0, EPA.
7. Consultation with Appalachian-Southern Extension and Research personnel and Apple producers.
8. Noncitrus Fruits and Nuts 1996 Summary. 1997. Agricultural Statistics Board, NASS, USDA.

Date: 01/28/99